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HANDBOOK
OPERATION INSTRUCTIONS

SIGNAL-GENERATOR

AN/USM-16

PART NO. 750000

AF STOCK NUMBER 7CAC-363-957

(BYRON JACKSON)

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SECTION I
DESCRIPTION

1-1. GENERAL. This publication is issued as the basic Handbook of Operating Instructions for the AN/USM-16 Signal Generator Set, Model BJ 75A, Part No. 750000, manufactured by the Byron Jackson Company, Electronic Division, Pasadena, California (see figure 1-1).

1-2. PURPOSE. The AN/USM-16 unit is a portable multipurpose signal-generator set for use in applications requiring a source of continuous-wave, amplitude-modulated, frequency-modulated, pulse-modulated, or swept-frequency output at carrier frequencies of 10 to 440 mc.

1-3. DESCRIPTION. (See figure 1-1 and refer to Table I.) The major component of the AN/USM-16 set is R-F Signal Generator SG-47/USM-16. The remainder of the components are accessories for the SG-47/USM-16 unit. These include the CY-852/USM-16 case, the MX-1544/USM-16 test prod, five CG-409A/U cords, the CX-337/U cord, three UG-255/U adapters, and two UG-201/U adapters. In addition, a schematic circuit diagram and spares are included. An external primary power source (a-c) is required for operation.

1-4. R-F SIGNAL GENERATOR SG-47/USM-16. (See figure 1-1.) The SG-47/USM-16 unit contains the following major assemblies and circuits:

a. An R-F Unit which is a beat-frequency oscillator capable of generating carrier frequencies from 10 to 440 mc.

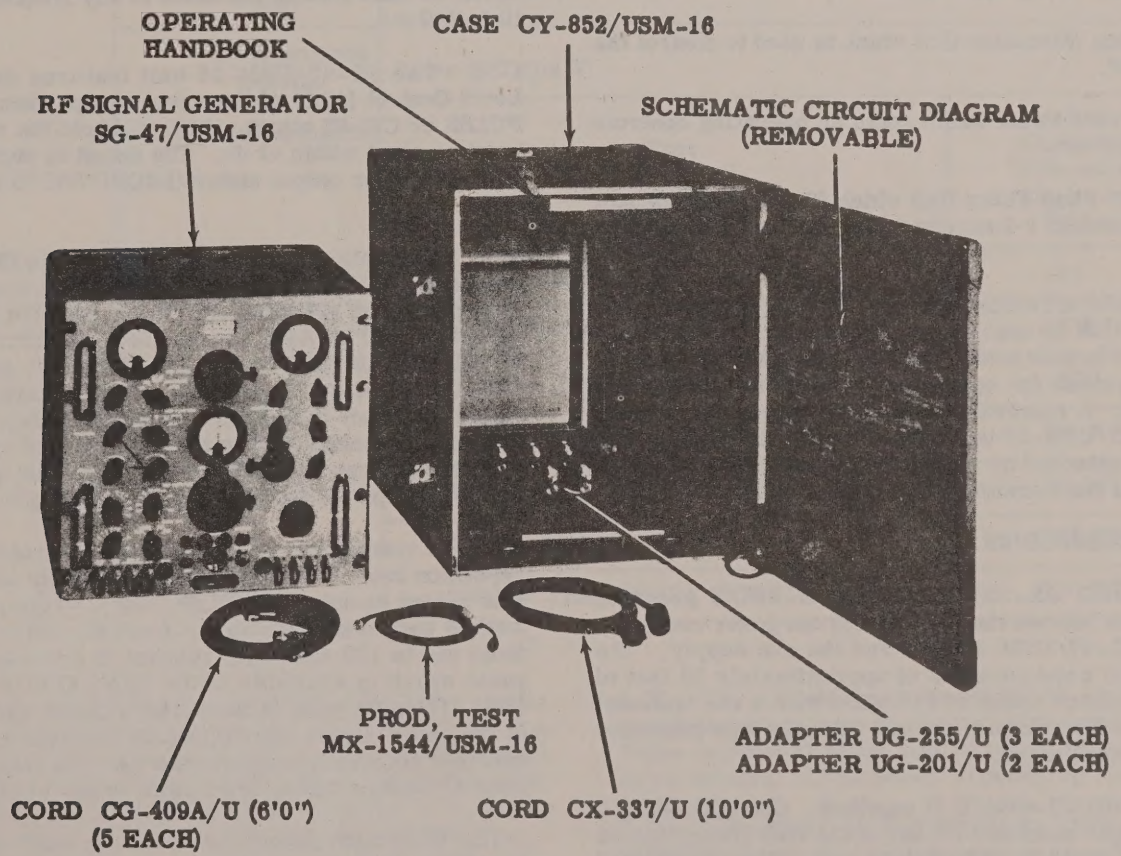


Figure 1-1. Typical View

b. An Automatic Frequency Stabilization Unit (AFS) which locks the output signal to the selected frequency and stabilizes the frequency against the effects of vibration, line-voltage fluctuation, carrier shift, and incidental FM.

c. A Power Supply Unit which supplies B+ and filament voltages necessary for operation.

d. A Sweep-Frequency Modulator Unit (SFM) which contains a sawtooth generator for swept-frequency modulation and an audio oscillator for amplitude or frequency modulation of the r-f carrier.

e. A Pulse Generator Unit capable of generating pulses from 50 to 5000 pps with variable pulse width and variable pulse delay. This signal may be used for pulse modulation of the r-f carrier or as a separate video pulse.

f. A Heterodyne Calibrator (Het Cal) which is used to adjust the r-f output frequency at 5, 1, or 0.1 mc intervals with an accuracy of ±200 cps.

g. An R-F Filament and Metering Unit which supplies regulated filament voltage to the interpolation oscillator.

h. An Interpolation Oscillator Unit used in conjunction with AFS (for accurate tuning between crystal check points) and sweep operation.

i. A step Attenuator Unit which is used to control the r-f output.

j. A Front Panel which contains operating controls and indicators.

k. A Hi-Pass Filter Unit which filters the r-f output and supplies an r-f sample to the Het Cal unit and AFS unit.

1-5. CASE CY-852/USM-16. (See figure 1-1.) The CY-852/USM-16 case is used for transit of the AN/USM-16 set. The case contains an accessory box with mounting provisions for operating spares and accessories supplied. A removable schematic circuit diagram of the SG-47/USM-16 unit is fastened to the cover. The cover is attached by eight latches and effects a watertight seal (immersion proof) when closed.

1-6. ACCESSORIES.

1-7. CORD CX-337/U. Cord CX-337/U provides connection between the 115V 50-450 cps power connector on the SG-47/USM-16 unit and the a-c supply. The CX-337/U cord consists of approximately 10 feet of two-conductor cable of #16 wire with a conventional male power plug on one end and a female-type connector on the opposite end.

1-8. CORD CG-409A/U (5 supplied). Cord CG-409A/U is the output connector for any of the BNC connectors on the panel of the SG-47/USM-16 unit. The CG-409A/U cord consists of approximately six feet of RG-58A/U coaxial cable with a UG-88B/U connector at each end.

1-9. TEST PROD MX-1544/USM-16. The MX-1544/USM-16 test prod is used to obtain a signal proportional to the r-f response at various stages in a circuit being tested by a swept-frequency signal. The MX-1544/USM-16 test prod consists of approximately six feet of RG-58A/U cable with a probe assembly at one end and a UG-88B/U connector at the opposite end (for connection to the PROBE INPUT connector on the SG-47/USM-16 unit).

1-10. ADAPTER UG-255/U (3 supplied). The UG-255/U adapter is used to adapt a UHF connector to BNC series connectors.

1-11. ADAPTER UG-201/U (2 supplied). The UG-201/U adapter is used to adapt Type-N-series connectors to BNC-series connectors.

1-12. SPARE PARTS. Spare fuses, pilot lamps, and crystals are supplied with the AN/USM-16 set (refer to Table II). Except for two fuses located on the front panel of the SG-47/USM-16 unit, these spare parts are located in the accessory box.

1-13. CAPABILITIES AND LIMITATIONS OF THE EQUIPMENT.

1-14. A frequency-stabilized and amplitude-level-controlled output up to 0.224 volts (0/dbm) into a low-VSWR 50-ohm load is available at any frequency from 10 to 440 mc.

1-15. The SG-47/USM-16 unit features Automatic Level Control (ALC) of the output except when used for PULSE or CW-HI output. ALC will hold the r-f output level constant within ±1 db. The output is continuously indicated on an output meter (MICROVOLTS OUTPUT RF).

1-16. Automatic Frequency Stabilization (AFS), at any frequency within the range of 10 to 440 mc, can be turned on or off (FREQ STAB switch) with the following exceptions: The AFS circuit does not function when SWEEP X10, SWEEP X100, CW-HI output, or PULSE output is employed. After 30 minutes warm up, the output frequency is stabilized to within 500 cps ± 0.02% of output frequency during the first hour of operation, to within 500 cps ± 0.005% during the second hour, and within 200 cps ± 0.002% in any hour thereafter.

1-17. A video pulse of one to 30-usec duration with a repetition rate of 50 to 5000 pps is available at a separate output connector (PULSE OUT). This pulse, as well as the pulse-modulated r-f output, can be delayed from one to 100 usec with respect to a two-usec sync pulse which is available at the SYNC OUT connector (30). The sync pulse is coincident with the leading edge of the pulse trigger signal (internal or external). The external triggering signal may be of varying shapes such as square wave, triangular wave, or sine wave.

1-18. When used in conjunction with an auxiliary oscilloscope and the furnished test prod, the SG-47/USM-16 unit supplies a swept-frequency-modulated output which will display the r-f response of a network.

TABLE I. DESCRIPTION OF THE AN/USM-16

		Size	Weight	Remarks
Physical	AN/USM-16	22 1/4" wide 26 3/4" high 24 1/4" deep	163 pounds (approx)	
	SG-47/USM-16	19-1/4" wide 17-3/4" high 20" deep	95 pounds	Can be removed from instrument case and mounted on standard 19" relay rack
Service Conditions	Specified performance (after 30 minutes warm up)within the temperature range of -10°C to +30°C (+14°F to +86°F)			
	Can be operated, with some loss of accuracy, within the temperature range of -40°C to +55°C (-40°F to +131°F)			
	Will stand repeated 50-G shocks on each face, or vibration up to 3 Gs peak at 10 to 45 cps along any axis.			
Electrical	Primary Power Input	115 volts ±10%, 50 to 450 cps, single phase ac		
		Approximately 750 watts when first turned on		
		Approximately 500 watts after warm up; power factor 0.95		
	Frequency Range	10 to 440 mc/sec		
	Performance Details	Refer to Table V		
	Performance	Type of Operation	For Operation Procedure Refer to Table	
		CW-HI OUTPUT	VI	
		CW OUTPUT	VII	
		CW (CALIBRATED AND STABILIZED)	VIII	
		AMPLITUDE MODULATION	IX, X	
		FREQUENCY MODULATION	XI, XII	
		PULSE MODULATION	XIII, XIV	
		SWEEP FREQUENCY MODULATION	XV, XVI	

1-19. During SWEEP X10 and SWEEP X100 swept-frequency operation, a marker pip is provided on a separate baseline. The marker pip indicates a certain frequency as a reference point and can be used in conjunction with the swept-frequency display on an oscilloscope to check the r-f response of a network.

1-20. Manual control of the output is provided by a continuously variable attenuator followed by a calibrated step attenuator.

1-21. The r-f output may be amplitude- or frequency-modulated either from an internal or an external source. Pulse-modulated output may be triggered internally or by an external signal (refer to paragraph 1-26).

1-22. GENERAL SYSTEM OPERATION. The SG-47/USM-16 unit is a beat-frequency signal generator in which the output of a variable-frequency oscillator is mixed with the output of a fixed-frequency oscillator in an r-f mixer (see figure 1-2). The output of the r-f

TABLE II. EQUIPMENT SUPPLIED
(See Figure 1-1)

Quantity	Contents	AN Type Designation	Manufacturer's Type Designation
1	Signal Generator Set, consisting of the following:	AN/USM-16	Model BJ 75A, Part No. 750000
1	Transit Case	CY-852/USM-16	
1	R-F Signal Generator	SG-47/USM-16	Rollin Part No. 750001
1	Operating Instructions Handbook	T.O. 33A1-8-23-1	
1	Schematic Circuit Diagram		Schematic (750401)
1	Test Prod	MX-1544/USM-16	
1	Power Cord	CX-337/U	
5	Cord	CG-409A/U	
3	Adapter	UG-255/U	
2	Adapter	UG-201/U	
1	Set of Operating Spare Parts, consisting of the following:		
2	Miniature Lamp		No. 47 lamp, Incandescent (TSL)
2	Miniature Lamp		No. 43 lamp, Incandescent (TSL)
10	Fuse		314010, fuse, 10 amp, 250V, 3 AB (LTF)
5	Crystal Rectifier	JAN 1N69	
5	Crystal Rectifier	JAN 1N126	
5	Crystal Rectifier	JAN 1N128	
5	Crystal Rectifier		Rollin SP750549
3 pr	Crystal Rectifier		Rollin SP750631 (matched pair)
2 pr	Crystal Rectifier		MP 3013 (matched pair)

TABLE III. EQUIPMENT REQUIRED BUT NOT SUPPLIED

Quantity	Equipment	AN Type Designation
1	Oscilloscope	AN/USM-24 or equivalent
1	600 ohm Headset	HS-33 or equivalent

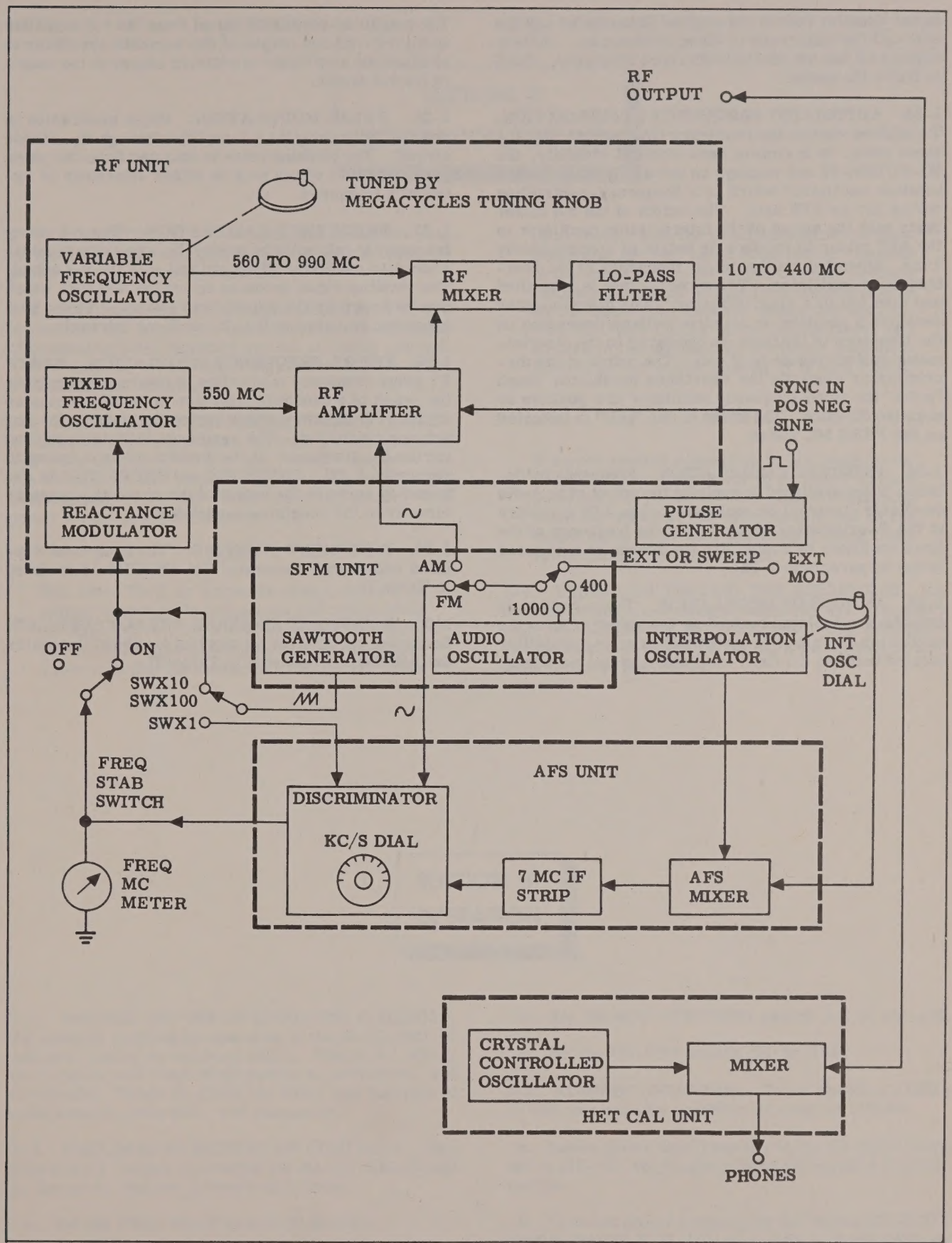


Figure 1-2. Simplified Block Diagram

mixer contains both of the original frequencies and the sum and the difference of these frequencies. Filters remove all but the desired difference frequency, which is fed to the output.

1-23. AUTOMATIC FREQUENCY STABILIZATION. To achieve continuous frequency coverage and, at the same time, to maintain near-crystal stability, the SG-47/USM-16 unit employs an extremely stable interpolation oscillator which is a frequency-controlling device for an AFS loop. The output of the r-f mixer beats with the output of the interpolation oscillator in the AFS mixer to produce an output of approximately 7 mc, depending on the output frequency of the beat-frequency oscillator. The mixer output is amplified and then fed to a discriminator. The discriminator develops a positive or negative voltage depending on the frequency of the input as compared to the discriminator center frequency (7 mc). The output of the discriminator controls the reactance modulator which "pulls" the fixed-frequency oscillator in a positive or negative direction. The extent of this "pull" is indicated on the FREQ MC meter.

1-24. FREQUENCY MODULATION. Frequency modulation is accomplished by applying the output of an audio oscillator (internal or external) to the AFS circuitry at the discriminator which varies the frequency of the fixed oscillator by controlling the reactance modulator (refer to paragraph 1-23).

1-25. AMPLITUDE MODULATION. The r-f output is amplitude modulated by feeding the output of an audio oscillator (internal or external) to an r-f amplifier located between the fixed oscillator and the r-f mixer. The amplitude-modulated signal from the r-f amplifier is mixed with the output of the variable oscillator to produce an amplitude-modulated signal at the output of the r-f mixer.

1-26. PULSE MODULATION. Pulse modulation is obtained by blocking the r-f amplifier through its cathode circuit. The blocking pulse is obtained from the pulse generator unit which may be either internally or externally triggered.

1-27. FREQUENCY CALIBRATION. The r-f output frequency is calibrated by mixing the output of a crystal-controlled oscillator (Het Cal Unit) with the r-f output. The resulting signal produces an audible beat note which can be heard by the use of head phones. These beat notes can be heard at 0.1, 1, or 5-mc intervals.

1-28. SWEPT-FREQUENCY MODULATION. SWEEP X1 swept-frequency modulation is obtained by applying the output of a sawtooth generator to the discriminator of the AFS circuitry which varies the input to the reactance modulator. The reactance modulator in turn varies the frequency of the fixed oscillator (refer to paragraph 1-23). SWEEP X10 and SWEEP X100 is obtained by applying the output of the sawtooth generator directly to the reactance modulator.

1-29. EQUIPMENT SUPPLIED. The equipment supplied with Signal Generator Set AN/USM-16 is listed in Table II.

1-30. EQUIPMENT REQUIRED BUT NOT SUPPLIED. Equipment required but not supplied for Signal Generator Set AN/USM-16 is listed in Table III.

SECTION II
PREPARATION FOR USE

2-1. OPERATING SITE. The Signal Generator may be operated in any dry, protected area near an external power source (refer to Table I).

2-2. ENVIRONMENTAL REQUIREMENTS. The unit is designed for laboratory installation where extremes of temperature and humidity are not normally present. Table I lists the various operating characteristics under environmental conditions.

2-3. EXTERNAL POWER REQUIREMENTS. The SG-47/USM-16 unit requires an external power source of 115 volts ±10%, 50 to 450 cps, single-phase. The SG-47/USM-16 unit requires approximately 750 watts starting power and 500 watts operating power. The power factor is approximately 0.95.

NOTE

For low VSWR or accurate measurement of output, output cable connectors and cables shall be inspected to insure that no cable is crushed, that connections to connectors are carefully made, and that the connectors themselves make good contact with the panel connector and connectors on the instrument being tested. Defects in the output cables or connectors may produce discontinuities that will produce standing waves on the connecting cables. Since the MICROVOLTS OUTPUT RF meter reads power delivered to the attenuator, it will not indicate a loss of power output caused by a high VSWR.

NOTE

If a good ground connection is not made to the unit, the case may seem to be above ground potential. If possible, this ground connection shall be made at the termination end of the output cable to avoid ground loops which could upset certain measurements.

2-4. TUNING OR TESTING THE EQUIPMENT. No special tuning or testing procedures are necessary prior to operation of the equipment. The equipment is tuned and self-tested during each operational procedure (refer to Section III).

SECTION III
OPERATION

3-1. PURPOSE AND USE OF OPERATING CONTROLS. All controls required for operation of the SG-47/USM-16 unit are located on the front panel. Figure 3-1 shows the location and name of all controls, indicators, and terminals. Table IV gives the name and function of each control, indicator, and connector.

3-2. PRELIMINARY SETTING OF CONTROLS. (See figure 3-1.) Before connecting the SG-47/USM-16 unit to the power source, proceed as follows:

a. Set the FREQ STAB switch (7) to OFF.

b. Set the MOD SIGNAL switch (5) to EXT OR SWEEP.

c. Set the MOD FUNCTION switch (10) to CW-AM.

d. Set the ON-OFF switch (34) to OFF.

3-3. STANDBY OPERATION. To put the SG-47/USM-16 unit in a standby condition proceed as follows:

a. Insert power input plug end of the CX-337/U cord into a 115-volt single-phase 50 to 450-cycle a-c power source.

b. Connect power output plug end of the CX-337/U cord to the 115 V 50-450 cps power connector (35) on the SG-47/USM-16 unit.

CAUTION

Leave the SG-47/USM-16 unit in a standby condition at all times, whether it is being used or not, after the unit is installed in the operating location. During standby operation, power is applied to the interpolation-oscillator heater in order to prevent condensation of moisture and to keep the interpolation oscillator at a constant temperature to assure stability of operation.

3-4. STARTING PROCEDURE. To start the unit, set the ON-OFF switch (34) to ON.

CAUTION

Do not connect the output circuit (RF OUTPUT connector (41) to a circuit (such as a transponder) that will feed more than 1/2 watt back into the output of the SG-47/USM-16 unit.

3-5. WARM-UP PROCEDURE. With the ON-OFF switch in the ON position, allow the unit to warm up at least 30 minutes (refer to Table V).

CAUTION

If the ambient temperature is below -10°C (+14°F) or the SG-47/USM-16 unit has been stored at a low temperature, allow one hour for the warm-up.

3-6. OPERATION. The detailed procedures for each type of operation of the SG-47/USM-16 unit are listed in Tables VI thru XVI and as outlined in paragraphs 3-7 thru 3-20. The performance of each type of operation is listed in Table V. The output frequency of the SG-47/USM-16 unit is not adjusted in a conventional manner. Therefore, the two procedures for adjusting the output frequency and the procedure for swept-frequency operation with marker pip are given a more complete description.

3-7. TUNING TO WITHIN ±2 MC OF A DESIRED FREQUENCY. To obtain a tuning accuracy of ±2 mc (without AFS), tune the SG-47/USM-16 unit in a conventional manner, using the megacycles tuning knob (6). With the FREQ STAB switch (7) OFF, rotate the megacycles tuning knob until the desired frequency is shown on the MEGACYCLES dial (2). The dial is calibrated to within ±2 mc. This type of tuning is used for rapid search or scanning the band from 10 to 440 mc when the highest degree of stability is not required or where extreme frequency accuracy is not necessary. (Refer to Tables VI and VII.)

3-8. ADDITIONAL ACCURACY BEYOND ±2 MC. To obtain additional accuracy (better than ±2 mc) at 5- or 1-mc intervals, turn the XTAL CHECK switch (13) to the 5 MC position and zero beat the output by use of the megacycles tuning knob (6). The zero beat is heard by connecting a pair of 600-ohm headphones to the PHONES connector (36) on the front panel.

3-9. Set the XTAL CHECK switch (13) to 1 MC and rotate the megacycles tuning knob (6) toward the desired frequency. Each time a 1-mc interval is passed, a zero beat note should be heard. Count the 1-mc intervals until the desired frequency is reached.

3-10. AFS TUNING TO WITHIN 1000 CPS OF THE DESIRED FREQUENCY. To operate with AFS or to tune to within 1000 cps of the desired frequency, set megacycles tuning knob (6) as outlined in paragraph 3-11. (Refer to Table VIII.)

3-11. Set the megacycles tuning knob (6) to the nearest 5-mc multiple of the desired frequency. Below each 5-mc marking on the MEGACYCLES dial (2) there is an INT OSC INDEX (42) number. Set the INT OSC dial (21) to the index number indicated. Set the FREQ STAB switch (7) to ON. AFS is now in operation, maintaining frequency stabilization.

NOTE

If the FREQ MC meter (11) needle deflects erratically it indicates that the MEGACYCLES dial (2) has to be moved slightly to achieve frequency "lock".

3-12. For the remainder of the tuning procedure, rotation of the megacycles tuning knob (6), up to the point where "lock" is lost, will produce a change in output frequency of less than 300 cycles, because the AFS loop will correct for any change produced within the AFS loop (refer to NOTE, paragraph 3-11). The megacycles tuning knob (6) now acts as an electrical zeroing or referencing adjustment for the FREQ MC meter (11) only.

NOTE

During frequency stabilized AM operation, incidental frequency modulation of the output may be reduced to a very low value by returning the FREQ MC meter (11) to zero by use of the megacycles tuning knob (6). Moving the indicating pointer several megacycles, by rotating the megacycles tuning knob (6) (with AFS in operation), will change the actual output frequency less than 300 cycles. For extreme accuracy, this shift may be corrected by use of the KC/S dial (17).

3-13. The INT OSC dial (21), XTAL CHECK switch (13), the FREQ MC meter (11), and a set of headphones are used for tuning between the 5-mc points. The FREQ MC meter (11) is returned to center zero by rotating the megacycles tuning knob (6). Continue tuning by setting the METER RANGE switch (12) to 3 MC, the XTAL CHECK switch (13) to 1 MC. While listening for beat notes in the headphones, rotate the INT OSC dial (21) until the proper number of megacycles has been added or subtracted from the 5-mc setting. The approximate change in output frequency is indicated on the FREQ MC meter (11). A beat note will be heard in the headphones each time the output frequency is changed by one megacycle. To increase a 5-mc setting by 3 mc (e.g., change the output frequency from 135 mc to 138 mc), rotate the INT OSC

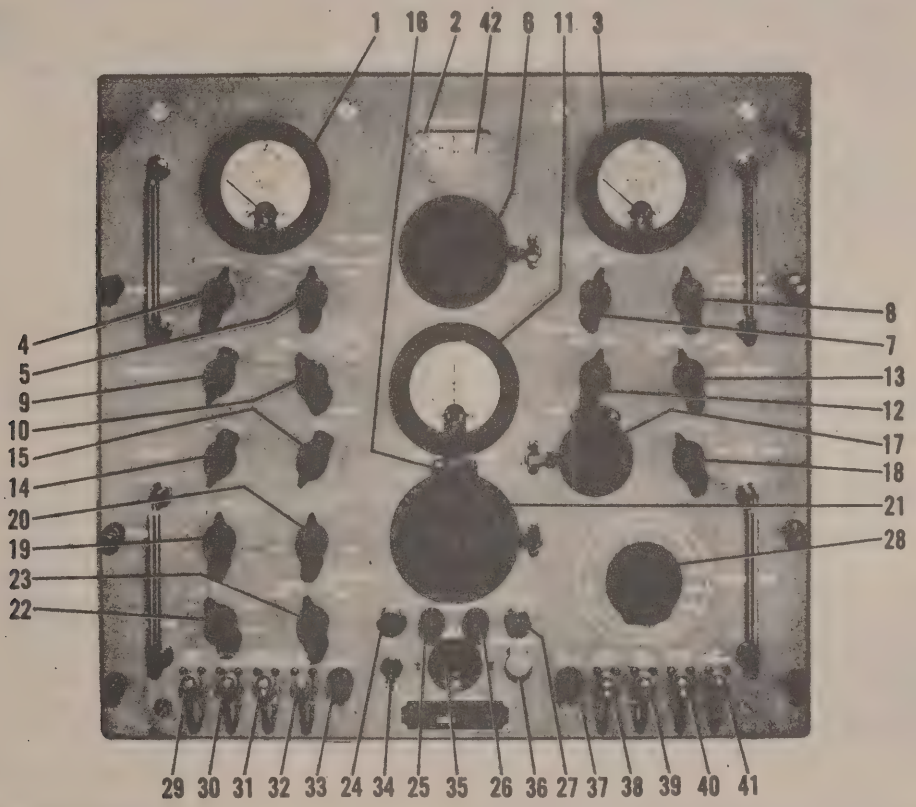
dial (21) until the third beat note is heard. At the third beat note the FREQ MC meter (11) will read approximately +3. The FREQ MC meter (11) is then zeroed by adjusting the megacycles tuning knob (6). For final tuning, readjust the INT OSC dial (21) for a zero beat note in the headphones. The output frequency is now stabilized at the desired multiple of one megacycle.

3-14. To tune to tenths of a megacycle, set the XTAL CHECK switch (13) at 100 KC and the METER RANGE switch (12) at 1 MC. Rotate the INT OSC dial (21) while counting the 100-kc beat notes in the headphones. The frequency change is verified by the FREQ MC meter (11).

3-15. For final tuning, beyond 0.1 mc, set the KC/S dial (17) in a positive or negative direction. Each division on the dial represents one kilocycle.

NOTE

Frequently, it is possible to reach the desired frequency without returning the FREQ MC meter (11) to zero, but this may introduce an undesirable amount of incidental FM or reduce the security of the locking effect of the AFS. The FREQ MC meter (11) shall be set to within 0.5 mc of center zero by use of the megacycles tuning knob (6) at final adjustment.



1. % MOD FREQ DEV ± KC/S Meter
2. MEGACYCLES Dial
3. MICROVOLTS OUTPUT RF Meter
4. % MOD AM Control
5. MOD SIGNAL Switch
6. Megacycles Tuning Knob
7. FREQ STAB Switch
8. CALIBRATE RF OUTPUT Control
9. FREQ DEV Control
10. MOD FUNCTION Switch
11. FREQ MC Meter
12. METER RANGE Switch
13. XTAL CHECK Switch
14. MARKER Control
15. PROBE Control
16. INDEX
17. KC/S Dial
18. HET CAL AMP Control
19. PULSE DELAY Control
20. REP RATE PPS Control
21. INT OSC Dial
22. PULSE WIDTH Control
23. SYNC SEL Control
24. Pilot Lamp
25. 10 AMPS Fuse
26. 10 AMPS Fuse
27. HEATER Lamp
28. ATTENUATOR Switch
29. PULSE OUT Connector
30. SYNC OUT Connector
31. SYNC IN POS NEG SINE Connector
32. EXT MOD Connector
33. SPARE Fuse
34. ON-OFF Switch
35. 115 V 50-450 cps Power Connector
36. PHONES Connector
37. SPARE Fuse
38. VERT DISPLAY Connector
39. HOR SWEEP Connector
40. PROBE INPUT Connector
41. RF OUTPUT Connector
42. INT OSC INDEX

Figure 3-1. Front Panel Controls

3-16. SWEPT-FREQUENCY OPERATION. (See figure 3-2.) Swept-frequency operation provides a visual display of the r-f response of a network. To set up for swept-frequency operation proceed as follows:

a. Adjust for swept-frequency modulation on SWEEP X1, SWEEP X10 or SWEEP X100. (Refer to Tables XV and XVI.)

b. Connect the VERT DISPLAY (38) to the vertical input of an AN/USM-24 scope.

c. Connect the HOR SWEEP (39) to the horizontal input of an AN/USM-24 scope.

d. Connect the MX-1544/USM-16 test prod to the PROBE INPUT CONNECTOR (40).

e. Connect RF OUTPUT connector (41) to the network or circuit to be tested.

f. Apply the MX-1544/USM-16 test prod to the stage of the network to be tested. (The capacity of the test prod is less than 3 uuf.) The frequency range is 10 to 100 mc. The output of the stage will be displayed on the scope.

CAUTION

Do not connect the test prod to more than 500V dc or 20V ac rms.

g. Adjust test-prod-signal amplitude with PROBE control (15).

3-17. Swept-frequency operation on SWEEP X10 and SWEEP X100 supplies a marker pip on a separate base line from that of the displayed signal. The marker pip occurs at the frequency to which the SG-47/USM-16 unit would be tuned if AFS were in operation (because the marker pip is generated by the AFS circuitry).

3-18. Adjust marker pip amplitude with MARKER control (14).

3-19. To change the frequency of the marker pip, vary the INT OSC dial (21).

3-20. The frequency of the marker is best identified by first adjusting the SG-47/USM-16 unit for CW (CALIBRATED AND STABILIZED) output using AFS and setting the output to the desired marker frequency (refer to Table VIII). Then, before switching to SWEEP X10 or SWEEP X100 (on MOD FUNCTION switch (10)), determine how many divisions the INT OSC dial (21) must be moved to change the output frequency one mc. This is determined by use of the heterodyne calibrator with the XTAL CHECK switch (13) set to 1 MC. Divide this number of divisions by 10. The resultant figure shows how many divisions the INT OSC dial (21) must be moved to change the marker-pip frequency 0.1 mc. This figure must be recalculated each time the frequency is changed more than ±3 mc.

NOTE

If the marker moves off the scope, if zero is reached too soon on the INT OSC dial (21), or if any discontinuity in marker presentation is experienced, move the megacycles tuning knob (6) to the 5-mc multiple that is on the opposite side of the desired frequency from that which the original marker adjustment was made and repeat the procedure given in paragraph 3-20.

3-21. STOPPING PROCEDURE. To stop operation, return the SG-47/USM-16 unit to "standby operation" by setting the ON-OFF switch (34) to OFF (refer to paragraph 3-3).

3-22. INSPECTION. During operation of the SG-47/USM-16 unit at normal temperature, the HEATER lamp (27) should alternately glow dimly and go out as thermostatically controlled heaters function. At low temperature the lamp should glow brightly and go out as the thermostatically controlled heaters function.

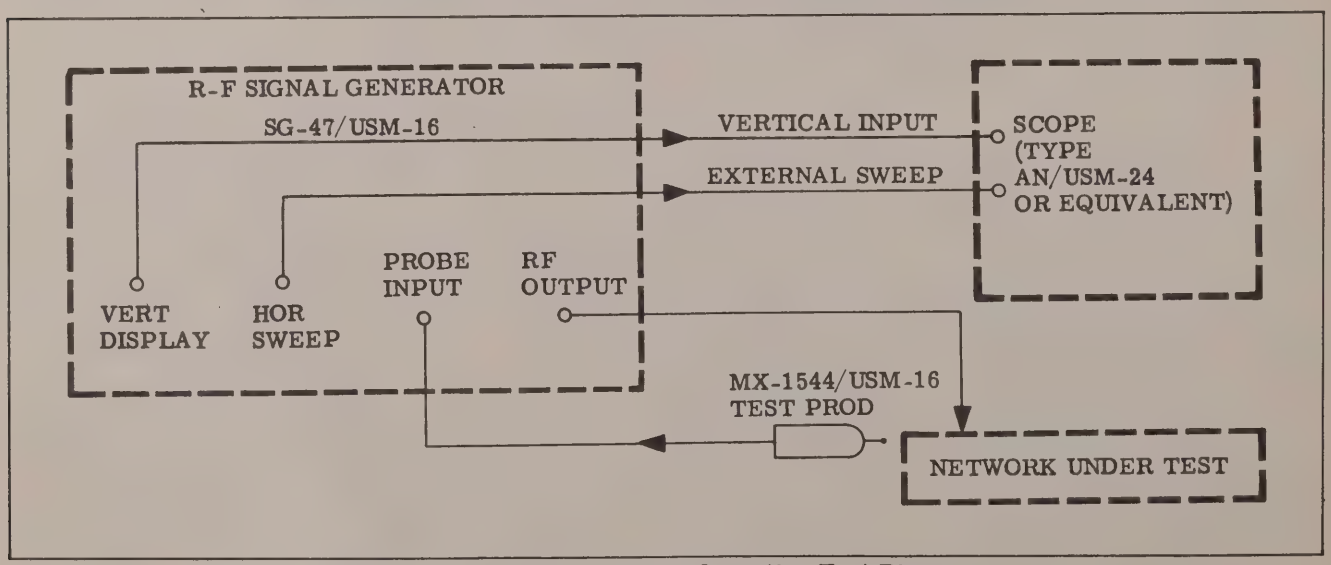


Figure 3-2. Swept Frequency Operation Test Diagram

TABLE IV. OPERATING CONTROLS, INDICATORS, AND TERMINALS
(See Figure 3-1)

Index No.	Designation	Function
1	% MOD FREQ DEV ± KC/S	Indicates modulation or deviation of r-f output.
2	MEGACYCLES	Tuning dial scale.
3	MICROVOLTS OUTPUT RF	Output level reference meter.
4	% MOD AM	Adjusts level (or %) of AM.
5	MOD SIGNAL	Selects modulating signal.
6		Megacycles tuning knob (refer to paragraph 3-7).
7	FREQ STAB	Turns AFS (Automatic Frequency Stabilization) ON or OFF.
8	CALIBRATE RF OUTPUT	Adjusts r-f output level.
9	FREQ DEV	Adjusts FM deviation and sweep width
10	MOD FUNCTION	Selects modulation type and range in the case of sweep-frequency modulation.
11	FREQ MC	Indicates frequency change of r-f output (refer to paragraph 3-13).
12	METER RANGE	Adjusts FREQ MC meter range to 1 mc or 3 mc.
13	XTAL CHECK	Selects crystal check points.
14	MARKER	Adjusts marker amplitude.
15	PROBE	Adjusts test-prod-signal gain.
16	INDEX	Interpolation-oscillator index reading.
17	KC/S	Adjusts r-f output to within 1000 cps of desired frequency.
18	HET CAL AMP	Adjusts crystal-check beat-note amplitude.
19	PULSE DELAY	Adjusts pulse delay.
20	REP RATE PPS	Adjusts pulse-repetition rate.
21	INT OSC	Interpolation-oscillator tuning knob and dial (refer to paragraphs 3-13 and 3-14).
22	PULSE WIDTH	Adjusts pulse width.
23	SYNC SEL	Selects type of pulse synchronization.
24		Pilot lamp (red), indicates when instrument is on.
25	10 AMPS	Active line fuse holder.
26	10 AMPS	Active line fuse holder.
27	HEATER	Lamp indicates power is applied to interpolation-oscillator heater (lamp cycles off and on whether power switch (34) is OFF or ON).

TABLE IV. OPERATING CONTROLS, INDICATORS, AND TERMINALS (cont)
(See Figure 3-1)

Index No.	Designation	Function
28	ATTENUATOR	Adjusts r-f output level in steps. Calibrated in microvolts and DBM.
29	PULSE OUT	Video-pulse output connector (BNC).
30	SYNC OUT	Synchronization-pulse output connector (BNC).
31	SYNC IN POS NEG SINE	Synchronization-signal input connector (BNC).
32	EXT MOD	AM-FM external-modulation-signal input connector (BNC).
33	SPARE	Spare-fuse holder.
34	ON-OFF	Applies power to SG-47/USM-16.
35	115 V 50-450	Primary-power connector.
36	PHONES	Connector for headphones to obtain signal from heterodyne-calibrator amplifier.
37	SPARE	Spare-fuse holder.
38	VERT DISPLAY	Output-signal connector for auxiliary-oscilloscope, vertical-deflection circuit (BNC).
39	HOR SWEEP	Output-signal connector for auxiliary-oscilloscope horizontal-deflection circuit (BNC).
40	PROBE INPUT	Connector for MX-1544/USM-16 test prod (BNC).
41	RF OUTPUT	Connector for output r-f signal (BNC).
42	INT OSC INDEX	Interpolation-oscillator index numbers.

TABLE V. OUTPUT PERFORMANCE CHARACTERISTICS (cont)

ation	Modulating Frequency		Modulated Output		
Output	Internal	External	Modulation or Deviation	Accuracy of Indication (% MOD FREQ DEV ± KC/S meter)	
calibrated	50 to 5000 pps	SYNC IN POS NEG SINE NOTE May be triggered by external signal of 150 to 5000 cps. May be sine, rectangular, or other wave shape.			

Item	Syn Sig
Amplitude	10V or le
Width	--
Repetition Rate	150 5000
Rise Time	--
Decay Time	--
Top of Pulse	--
Delay	--
Accuracy of pulse w	
Accuracy of repetiti	
Input impedance 100	
The sync in signal n sine wave. The SC signal without dam	

TABLE IV. OPERATING CONTROLS, INDICATORS, AND TERMINALS (cont)
(See Figure 3-1)

Index No.	Designation	Function
28	ATTENUATOR	Adjusts r-f output level in steps. Calibrated in microvolts and DBM.
29	PULSE OUT	Video-pulse output connector (BNC).
30	SYNC OUT	Synchronization-pulse output connector (BNC).
31	SYNC IN POS NEG SINE	Synchronization-signal input connector (BNC).
32	EXT MOD	AM-FM external-modulation-signal input connector (BNC).
33	SPARE	Spare-fuse holder.
34	ON-OFF	Applies power to SG-47/USM-16.
35	115 V 50-450	Primary-power connector.
36	PHONES	Connector for headphones to obtain signal from heterodyne-calibrator amplifier.
37	SPARE	Spare-fuse holder.
38	VERT DISPLAY	Output-signal connector for auxiliary-oscilloscope, vertical-deflection circuit (BNC).
39	HOR SWEEP	Output-signal connector for auxiliary-oscilloscope horizontal-deflection circuit (BNC).
40	PROBE INPUT	Connector for MX-1544/USM-16 test prod (BNC).
41	RF OUTPUT	Connector for output r-f signal (BNC).
42	INT OSC INDEX	Interpolation-oscillator index numbers.

TABLE V. OUTPUT PERFORMANCE CHARACTERISTICS

Type of Operation	Frequency Range (RF CARRIER)	Output (into a 50-ohm load)	Accuracy of Indication		Modulating Frequency		Modulated Output		Other Characteristics or Limitations
			Frequency	Output	Internal	External	Modulation or Deviation	Accuracy of Indication (% MOD FREQ DEV ± KC/S meter)	
CW-HI	10 to 440 mc	0.35V minimum	±2 mc. Output can be checked against internal crystal-controlled oscillator at 5- and 1-mc points.	Not calibrated					ALC does not function for CW-HI operation.
CW	10 to 440 mc	0.1uV to 0.224V	±2 mc. Output can be checked against internal crystal-controlled oscillator at 5- and 1-mc points.	±3 db					ALC will hold r-f output level constant within ± 1 db over entire tuning range, except in -6 dbm position. In -6 dbm position of the variable attenuator, r-f output level will not hold constant within ± 1 db over entire tuning range unless r-f output connector is terminated into low VSWR, 50-ohm load. Output controlled by continuously variable attenuator followed by 13-step attenuator calibrated from -6 to -126 DBM.
CW (CALIBRATED AND STABILIZED)	10 to 440 mc	0.1uV to 0.224V	±200 cps at crystal check points. ±1000 cps between crystal check points.	±3 db					ALC will hold r-f output level constant within ± 1 db over entire tuning range, except in -6 dbm position. In -6 dbm position of the variable attenuator, r-f output level will not hold constant within ± 1 db over entire tuning range unless r-f output connector is terminated into low VSWR, 50-ohm load. Stability with AFS after 30 minutes warm-up: 500 cps plus 0.02% in first hour; 500 cps plus 0.005% in second hour; 200 cps plus 0.002% in any hour thereafter
AMPLITUDE MODULATION	10 to 440 mc	0.1uV to 0.224V	±200 cps at crystal check points. ±1000 cps between crystal check points.	±3 db	400 cps ±10%, sine wave. 1000 cps ±10%, sine wave. Distortion will not exceed 10%.	80 to 5000 cps with % modulation flat to within ±1 db. 10V or less across 1000 ohms. Distortion will not exceed 5%.	0 to 80% AM	±10% of full scale	Carrier shift - 200 cps +0.001%. Hum and noise - 40 db down from 80% modulation. Incidental FM - Less than 200 cps plus 20% of modulating frequency up to 80% AM from 80 to 5000 cps.
FREQUENCY MODULATION	10 to 440 mc	0.1uV to 0.224V	±200 cps at crystal check points. ±1000 cps between crystal check points.	±3 db	400 cps ±10%, sine wave. 1000 cps ±10%, sine wave. Distortion will not exceed 10%.	80 to 5000 cps sine wave. 10V or less. Distortion will not exceed 5%.	0 to ±75 kc	±5% of full scale	Stability of deviation with constant modulation voltage is within 6% for 10 to 440 mc and constant within 15% for 80 to 5000 cps. Incidental AM - Not to exceed 5%. Carrier shift - Less than 5% of frequency deviation (±12.5 kc to ±75 kc)
SWEPT FREQUENCY MODULATION									
SWEEP X1	10 to 440 mc	0.1uV to 0.224V	±200 cps at crystal check points. ±1000 cps between crystal check points.	±3 db			0 to ±75 kc	±10% of full scale for frequency deviation of ±12.5 kc to ±5000 kc	Jitter of center frequency - Less than 5% of sweep width. Linearity of Display - 5% (±75 kc), 10% (±5000 kc). Incidental AM - Amplitude constant within 2 db.
SWEEP X10	11 to 439 mc	0.1uV to 0.224V	±2 mc	±3 db			0 to ±750 kc		Stability of deviation - 5% (±12.5 kc to ±75 kc) 10% (±75 kc to ±7500 kc) Marker pip width - 5% of sweep width. (maximum)
SWEEP X100	15 to 435 mc	0.1uV to 0.224V	±2 mc	±3 db			0 to ±7500 kc		Horizontal sweep voltage provided for external oscilloscope (AN/USM-24 or equivalent). No marker pip for SWEEP X1.

TABLE V. OUTPUT PERFORMANCE CHARACTERISTICS (cont)

Type of Operation	Frequency Range (RF CARRIER)	Output (into a 50-ohm load)	Accuracy of Indication		Modulating Frequency		Modulated Output		Other Characteristics or Limitations
			Frequency	Output	Internal	External	Modulation or Deviation	Accuracy of Indication (% MOD FREQ DEV ± KC/S meter)	
PULSE MODULATION	10 to 440 mc	0.1 uv to 0.35V minimum	±2 mc	Not calibrated	50 to 5000 pps	SYNC IN POS NEG SINE NOTE May be triggered by external signal of 150 to 5000 cps. May be sine, rectangular, or other wave shape.			

Item	Sync In Signal	RF Pulse	Video Pulse	Sync Out Pulse
Amplitude	10V rms or less	0.1 uv to 0.35V minimum	10V at end of 6-foot 50-ohm cable terminated in 200 ohms.	10V at end of 6-foot 50-ohm cable terminated in 200 ohms.
Width	---	1 to 30 usec	1 to 30 usec	2 usec at 10% amplitude, synchronized with input signal
Repetition Rate	150 to 5000 cps	50 to 5000 pps	50 to 5000 pps	50 to 5000 pps
Rise Time	---	0.15 usec	0.15 usec	0.2 usec
Decay Time	---	0.3 usec	0.2 usec	---
Top of Pulse	---	Flat to 10%, no overshoot	Flat to 10%, no overshoot	---
Delay	---	1 to 100 usec		None

Accuracy of pulse width and delay - ±10%; ±10% plus 0.5 usec (from 1 to 10 usec)

Accuracy of repetition rate - ±10% at +10°C (+50°F) to +30°C (+86°F)
±20% at -10°C (+14°F) to +10°C (+50°F)

Input impedance 100,000 ohms.

The sync in signal may be positive or negative and of varying shapes including sine wave. The SG-47/USM-16 unit will accept 100V peak to peak sync in signal without damage to its circuitry.

Other Characteristics or Limitations			
c In nal	RF Pulse	Video Pulse	Sync Out Pulse
rms ss	0.1 uv to 0.35V minimum	10V at end of 6-foot 50-ohm cable terminated in 200 ohms.	10V at end of 6-foot 50-ohm cable terminated in 200 ohms.
--	1 to 30 usec	1 to 30 usec	2 usec at 10% amplitude, synchronized with input signal
to cps	50 to 5000 pps	50 to 5000 pps	50 to 5000 pps
--	0.15 usec	0.15 usec	0.2 usec
--	0.3 usec	0.2 usec	---
--	Flat to 10%, no overshoot	Flat to 10%, no overshoot	---
--	1 to 100 usec		None

idth and delay - ±10%; ±10% plus 0.5 usec (from 1 to 10 usec)

on rate - ±10% at +10°C (+50°F) to +30°C (+86°F)
±20% at -10°C (+14°F) to +10°C (+50°F)

,000 ohms.

ıay be positive or negative and of varying shapes including
-47/USM-16 unit will accept 100V peak to peak sync in
age to its circuitry.

TABLE VI. CW-HI OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1	ON-OFF (34) MOD FUNCTION (10) MOD SIGNAL (5) FREQ STAB (7)	OFF CW-AM CW-HI OUTPUT OFF	
2	Connect 115V ac ±10%, 50-450 cps, single-phase supply through power cord CX-337/U to 115V 50-450 cps power connector (35)		
3	ON-OFF (34)	ON	Allow 10 minutes warm-up.
4	Megacycles tuning knob (6)	Desired frequency	Indicated on MEGACYCLES dial (2). Frequency present at RF OUTPUT connector (41).
5	ATTENUATOR (28)	-6 DBM	Maximum voltage output.
6	CALIBRATE RF OUTPUT (8)	Maximum clockwise position	MICROVOLTS OUTPUT RF meter (3) will be off scale. The voltage at the RF OUTPUT connector (41) will be at least 0.35V (into a 50-ohm load).
	NOTE Any output from 0.1 uv up to a miminum of 0.35V may be obtained by proper setting of the CALIBRATE RF OUTPUT (8) and the ATTENUATOR (28).		

TABLE VII. CW OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1	ON-OFF (34) MOD FUNCTION (10) MOD SIGNAL (5) FREQ STAB (7)	OFF CW-AM EXT or SWEEP OFF	
2	Connect 115V ac ±10%, 50-450 cps, single-phase supply through power cord CX-337/U to 115V 50-450 cps power connector (35)		
3	ON-OFF (34)	ON	Allow 10 minutes warm-up.
4	Megacycles tuning knob (6)	Desired frequency	Indicated on MEGACYCLES dial (2). Frequency present at RF OUTPUT connector (41).
5	ATTENUATOR (28)	See Remarks	The voltage at the RF OUTPUT connector (41) is the reading of the MICROVOLTS OUTPUT RF meter (3) times the ATTENUATOR (28) setting; e.g., to obtain a 1500 uv output, set the ATTENUATOR (28) to -46 DBM (1k) and adjust the CALIBRATE RF OUTPUT (8) to 1.5 as indicated on the MICROVOLTS OUTPUT RF meter (3). The voltage at the RF OUTPUT connector (41) is 1.5 uv times 1k or 1500 uv.
6	CALIBRATE RF OUTPUT (8)	See Remarks	

TABLE VIII. CW (CALIBRATED AND STABILIZED) OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1	ON-OFF (34) MOD FUNCTION (10) MOD SIGNAL (5) FREQ STAB (7) METER RANGE (12) XTAL CHECK (13) ATTENUATOR (28) HET CAL AMP (18) KC/S (17)	OFF CW-AM EXT or SWEEP OFF 3 MC OFF -26 DBM Maximum clockwise position 0	
2	Connect 115V ac ±10%, 50-450 cps, single-phase supply through power cord CX-337/U to 115V 50-450 cps power connector (35)		
3	Connect 600-ohm headphones to PHONES connector (36).		
4	ON-OFF (34)	ON	Allow 30 minutes warm-up.
5	CALIBRATE RF OUTPUT (8)	Adjust for a reading on MICROVOLTS OUTPUT RF meter (3) of 0 to 3 DB	
6	Megacycles tuning knob (6)	5-mc multiple nearest the desired frequency	Indicated on MEGACYCLES dial (2)
7	INT OSC (21)	Number indicated on INT OSC INDEX (42) (lower scale)	
8	XTAL CHECK (13)	5 MC	
9	Megacycles tuning knob (6)	Adjust	Rock megacycles tuning knob (6) until a beat note is heard in the headphones and proceed immediately to Step 10.
10	FREQ STAB (7)	ON	The pointer of the FREQ MC meter (11) will deflect once or twice across the dial indicating the locker search is operating. When the pointer comes to rest, proceed to Step 11.
11	INT OSC (21)	Adjust for zero beat note	Rock INT OSC (21) until a zero beat note is heard in the headphones.
12	Megacycles tuning knob (6)	Adjust until FREQ MC meter (11) reads zero.	The output frequency is now stabilized at the 5-mc multiple nearest the desired frequency. With FREQ STAB (7) ON, moving MEGACYCLES dial (2) does not change frequency more than a few cycles, unless the dial is moved so far the signal loses "lock", indicated by FREQ MC meter needle sweeping across its scale repeatedly.
13	XTAL CHECK (13)	1 MC	

TABLE VIII. CW (CALIBRATED AND STABILIZED) OPERATION (cont)
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
14	INT OSC (21)	Adjust to raise or lower frequency toward the desired frequency until the beat note representing the correct 1-mc multiple is heard in the headphones	Frequency change from that obtained in Step 12 is indicated on FREQ MC meter (11). FREQ MC meter indicates direction of frequency change (± frequency change). Beat notes will be heard in the headphones at each 1 mc change in output frequency. (Refer to paragraphs 3-13 and 3-14.)
15	Megacycles tuning knob (6)	Adjust until FREQ MC meter (11) reads zero.	
16	METER RANGE (12)	1 MC	
17	Megacycles tuning knob (6)	Adjust until FREQ MC meter (11) reads zero.	
18	INT OSC (21)	Adjust for zero beat note.	The r-f output frequency is now locked and stabilized at the multiple of 1 mc nearest the desired frequency.
19	XTAL CHECK (13)	100 KC	
20	INT OSC (21)	Adjust to raise or lower frequency toward the desired frequency until the beat note representing the correct 100-kc multiple is heard in the headphones	Frequency change from that obtained in Step 18 is indicated on FREQ MC meter (11). Beat notes will be heard in the headphones at each 100-kc change in output frequency.
21	Megacycles tuning knob (6)	Adjust until FREQ MC meter (11) reads zero	
22	INT OSC (21)	Adjust for zero beat note and lock the dial.	The r-f output frequency is now locked and stabilized at the multiple of 100 kc nearest the desired frequency.
23	KC/S (17)	Adjust to raise or lower output frequency to the desired frequency. Lock the dial.	The r-f output frequency is now locked and stabilized within 1000 cps of the desired frequency.

TABLE IX. INTERNAL AMPLITUDE-MODULATION OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set to desired frequency and output as described in CW (CALIBRATED AND STABILIZED) or CW operation. (Refer to Tables VII and VIII.)	Desired output frequency and amplitude (CW) will be present at RF OUTPUT connector (41).
2	MOD SIGNAL (5)	400 or 1000	
3	% MOD AM (4)	Desired percent modulation	Indicated on % MOD FREQ DEV ± KC/S meter (1).
			The amplitude-modulated r-f signal will be present at the RF OUTPUT connector (41).
NOTE The use of AM modulation in excess of 80% may cause the output frequency to lose "lock" during AFS operation. To regain the frequency-locked condition, reduce the % AM modulation and retune until the "lock" is regained.			

TABLE X. EXTERNAL AMPLITUDE-MODUALTION OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set to desired frequency and output as described in CW (CALIBRATED AND STABILIZED) or CW operation. (Refer to Tables VII and VIII.)	Desired output frequency and amplitude (CW) will be present at RF OUTPUT connector (41).
2	MOD SIGNAL (5)	EXT OR SWEEP	
3	Connect external AM source to EXT MOD connector (32). Set external source (80 to 5000 cps) to desired modulating frequency and output to 10 V maximum.		
4	% MOD AM (4)	Desired percent modulation	Indicated on % MOD FREQ DEV ± KC/S meter (1).
			The amplitude-modulated r-f signal will be present at the RF OUTPUT connector (41).

TABLE XI. INTERNAL FREQUENCY-MODULATION OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW (CALIBRATED AND STABILIZED) or CW operation. (Refer to Tables VII and VIII.)	Desired output frequency and amplitude (CW) will be present at RF OUTPUT connector (41).
2	MOD SIGNAL (5)	400 or 1000	
3	MOD FUNCTION (10)	FM-X1	
4	FREQ DEV (9)	Desired deviation	Indicated on % MOD FREQ DEV ± KC/S meter (1).
			The frequency-modulated r-f signal will be present at the RF OUTPUT connector (41).

TABLE XII. EXTERNAL FREQUENCY-MODULATION OPERATION
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW (CALIBRATED AND STABILIZED) or CW operation. (Refer to Tables VII and VIII.)	Desired output frequency and amplitude (CW) will be present at RF OUTPUT connector (41).
2	MOD SIGNAL (5)	EXT OR SWEEP	
3	MOD FUNCTION (10)	FM-X1	
4	Connect an external signal source to EXT MOD connector (32). Set external source to desired modulating frequency (80 to 5000 cps) and output to 10 V maximum.		
5	FREQ DEV (9)	Desired deviation	Indicated on % MOD FREQ DEV ± KC/S meter (1).
			The frequency-modulated r-f signal will be present at the RF OUTPUT connector (41).

TABLE XIII. PULSE-MODULATION OPERATION (INTERNAL TRIGGERING SIGNAL)
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW-HI operation. (Refer to Table VI.)	Desired output frequency and amplitude will be present at RF OUTPUT connector (41).
2	SYNC SEL (23)	XI PPS or X10 PPS	
3	REP RATE PPS (20)	To desired repetition rate	50 to 5000 pps
4	PULSE WIDTH (22)	To desired pulse width	1 to 30 usec.
5	PULSE DELAY (19)	At least 1 usec	
6	MOD SIGNAL (5)	PULSE	The r-f pulse will be present at the RF OUTPUT connector (41).
			The peak pulse amplitude will be the level established in Step 1.
			To read peak pulse level during pulse operation, move MOD SIGNAL (5) to CW-HI OUPTUT and read on MICROVOLTS OUTPUT RF meter (3). Return MOD SIGNAL (5) to PULSE for pulse operation.
			A video pulse (r-f pulse envelope) will be present at the PULSE OUT connector (29).
			Synchronizing pulse will be present at SYNC OUT connector (30).
7	PULSE DELAY (19)	To desired pulse delay	The r-f pulse (and video pulse) will follow the sync out pulse by the number of micro-seconds indicated by the PULSE DELAY control (19).

TABLE XIV. PULSE-MODULATION OPERATION (EXTERNAL TRIGGERING SIGNAL)
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW-HI operation. (Refer to Table VI.)	Desired output frequency and amplitude will be present at RF OUTPUT connector (41).
2	SYNC SEL (23)	POS or NEG (as required)	
3	Connect an external triggering source of 150 to 5000 pps to SYNC IN POS NEG SINE connector (31). External triggering signal shall be 10 V or less positive or negative and may be of varying shapes including sine wave. The input impedance is 100,000 ohms.		
	NOTE The SG-47/USM-16 can accept 100 volts peak-to-peak signal at the SYNC IN POS NEG SINE connector (31) without damage.		

TABLE XIV. PULSE-MODULATION OPERATION (EXTERNAL TRIGGERING SIGNAL) (cont)
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
4	PULSE WIDTH (22)	To desired pulse width	
5	PULSE DELAY (19)	At least 1 usec	
6	MOD SIGNAL (5)	PULSE	The r-f pulse will be present at the RF OUTPUT connector (41).
			The pulse amplitude will be the level established in Step 1.
			To read peak pulse level during pulse operation, move MOD SIGNAL (5) to CW-HI OUTPUT and read on MICROVOLTS OUTPUT RF meter (3). Return MOD SIGNAL (5) to PULSE for pulse operation.
			A video pulse (r-f pulse envelope) will be present at the PULSE OUT connector (29).
			A synchronizing pulse will be present at SYNC OUT connector (30).
7	PULSE DELAY (19)	To desired pulse delay	The r-f pulse and (video pulse) will follow the sync out pulse by the number of micro-seconds indicated by the PULSE DELAY control (19).

TABLE XV. SWEPT-FREQUENCY-MODULATION OPERATION - SWEEP X1
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW (CALIBRATED AND STABILIZED) operation. (Refer to Table VIII.)	Desired output frequency and amplitude (CW) will be present at the RF OUTPUT connector (41).
2	MOD FUNCTION (10)	SWEEP X1	
3	FREQ DEV (9)	To desired deviation	Indicated on % MOD FREQ DEV ±KC/S meter (1).
			The swept frequency will be present at the RF OUTPUT connector (41).
			A horizontal sweep voltage synchronized to the sweep rate will be present at the HOR SWEEP connector (39).
			For use of test prod MX-1544/USM-16 refer to paragraphs 3-16 through 3-20 and see figure 3-2.

NOTE

SWEEP X1 can be used only with the FREQ STAB switch (7) in the ON position. Sweep-frequency output is frequency stabilized (AFS) only on the SWEEP X1 position.

TABLE XVI. SWEPT-FREQUENCY-MODULATION OPERATION - SWEEP X10 AND SWEEP X100
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
1		Set SG-47/USM-16 to desired frequency and output as described in CW operation. (Refer to Table VII.)	Desired output frequency and amplitude (CW) will be present at the RF OUTPUT connector (41).
2	MOD FUNCTION (10)	SWEEP X10 or SWEEP X100	
3	FREQ DEV (9)	To desired deviation	Indicated on % MOD FREQ DEV ± KC/S meter (1).
			The swept frequency will be present at the RF OUTPUT connector (41).
			For use of test prod MX1544/USM-16 and marker pip during swept frequency operation. (Refer to paragraphs 3-16 thru 3-20 and see figure 3-2.)
			A horizontal sweep voltage synchronized to the sweep rate will be present at the HOR SWEEP connector (39).
NOTE AFS does not operate during SWEEP X10 or SWEEP X100			
NOTE A marker pip is available on SWEEP X10 or SWEEP X100 but not for SWEEP X1. Refer to steps 4 thru 10 for the procedure on adjusting the frequency of the marker pip.			
4		Set SG-47/USM-16 for CW (CAL & STAB) operation with the frequency set to the desired marker pip frequency. (Refer to Table VIII.)	The marker pip occurs at the frequency to which the SG-47/USM-16 would be tuned if AFS were in operation.
5	XTAL CHECK (13)	1 MC	
6	INT OSC (21)	Determine how many divisions the INT OSC dial (21) must be moved to change the output frequency 1 mc	Divide this number by 10. The resultant figure is the number of divisions the INT OSC dial (21) must be moved to change the marker pip frequency 0.1 mc. Return INT OSC (21) to point determined in Step 4.
7	Repeat steps 1 thru 3.		
8	PROBE (15)	Adjust for desired amplitude of test prod signal.	
9.	MARKER (14)	Adjust for desired marker pip amplitude	The marker pip is on a separate base line from that of the displayed signal.

TABLE XVI. SWEPT-FREQUENCY-MODULATION OPERATION - SWEEP X10 AND SWEEP X100 (cont)
(Refer to Table V for performance)
(See Figure 3-1)

Step	Control	Setting	Results or Remarks
10	INT OSC (21)	Adjust if desired to change marker pip frequency according to the calibration obtained in step 6	
NOTE Repeat step 6 each time the frequency of the marker pip is changed more than ±3 mc.			
NOTE If the marker pip moves off the scope, if zero is reached too soon on the INT OSC dial (21), or if any discontinuity in marker pip presentation is experienced, move the megacycles tuning knob (6) to the 5-mc multiple that is on the opposite side of the desired frequency from that which the original marker pip adjustment was made and repeat steps 1 thru 10.			